

CLAIMS

I Claim:

- 1 1. A duplexer comprising:
 - 2 an input/output line;
 - 3 a transmit segment; connected to the input/output line; and,
 - 4 a receive segment, the receive segment including:
 - 5 a balun including:
 - 6 a first output,
 - 7 a second output,
 - 8 a first transmission line coupled between the
 - 9 input/output line and the first output, and
 - 10 a second transmission line coupled between the
 - 11 input/output line and the second output, and
 - 12 a differential filter connected to the first output and the second
 - 13 output, the differential filter including resonator elements connected so that
 - 14 at transmit band frequencies of the duplexer, the first output and the second
 - 15 output are shorted.

- 1 2. A duplexer as in claim 1 wherein at transmit band frequencies of
- 2 the duplexer, the first output and the second output are each shorted to a
- 3 reference voltage.

- 1 3. A duplexer as in claim 1 wherein at transmit band frequencies of
- 2 the duplexer, the first output and the second output are shorted to each
- 3 other.

1 4. A duplexer as in claim 1 wherein the resonator elements are
2 arranged so that the differential filter includes resonator elements arranged
3 in a paired half ladder structure.

1 5. A duplexer as in claim 1 wherein the resonator elements are
2 arranged so that the differential filter includes resonator elements arranged
3 in a full ladder structure.

1 6. A duplexer as in claim 1 wherein the resonator elements are
2 arranged so that the differential filter includes resonator elements arranged
3 in a lattice structure.

1 7. A duplexer as in claim 1 wherein the resonator elements are
2 arranged so that the differential filter includes resonator elements arranged
3 in both a paired half ladder structure and a full ladder structure.

1 8. A duplexer as in claim 1 wherein a length of the first transmission
2 line is chosen to cause a phase delay of approximately one fourth wave
3 length at receive band frequencies of the duplexer, and a length of the second
4 transmission line is chosen to cause a phase delay of approximately three
5 fourths wave length at the receive band frequencies of the duplexer.

1 9. A duplexer as in claim 1 wherein the transmit segment includes a
2 single ended filter including resonator elements connected so that at receive

3 band frequencies of the duplexer, an open circuit is presented by the single
4 ended filter to the input/output line.

1 10. A duplexer as in claim 1 wherein the resonator elements are each
2 implemented as a film bulk acoustic resonator (FBAR).

1 11. A method for providing filtering within a duplexer, the method
2 comprising the following steps:

3 (a) for signals at the transmit band frequencies, performing the
4 following substeps:

5 (a.1) providing passband transmission through a single-ended
6 filter of the duplexer, and

7 (a.2) providing a short circuit at a first input and second input
8 of a differential filter, the first input of the differential filter being connected
9 to an input/output line of the duplexer via a balun and the second input of
10 the differential filter being connected to the input/output line of the duplexer
11 via the balun; and,

12 (b) for signals at the receive band frequencies, performing the
13 following substep:

14 (b.1) providing passband transmission through the differential
15 filter of the duplexer.

1 12. A method as in claim 11 wherein substep (a.2) includes at
2 transmit band frequencies of the duplexer, shorting the first output and the
3 second output to a reference voltage.

1 13. A method as in claim 11 wherein substep (a.2) includes at
2 transmit band frequencies of the duplexer, shorting the first output and the
3 second output to each other.

1 14. A method as in claim 11 wherein step (b) additionally includes the
2 following substeps performed for signals at the receive band frequencies:
3 (b.2) providing a phase delay of approximately one fourth wave
4 length through a first transmission line within the balun, and
5 (b.3) providing a phase delay of approximately three fourths
6 wave length through a second transmission line within the balun, and

1 15. A method as in claim 11 wherein step (b) additionally includes the
2 following substep performed for signals at the receive band frequencies:
3 (b.2) providing an open circuit by the single-ended filter to the
4 input/output line.

1 16. A duplexer comprising:
2 an input/output line;
3 a transmit segment; connected to the input/output line; and,
4 a receive segment, the receive segment including:
5 a balun connected to the input/output line, the balun including:
6 a first output, and
7 a second output, and

8 a differential filter connected to the first output and the second
9 output, the differential filter shorting the first output and the second output
10 at transmit band frequencies of the duplexer.

1 17. A duplexer as in claim 16 wherein at transmit band frequencies of
2 the duplexer, the first output and the second output are each shorted to a
3 reference voltage.

1 18. A duplexer as in claim 16 wherein at transmit band frequencies of
2 the duplexer, the first output and the second output are shorted to each
3 other.

1 19. A duplexer as in claim 16 wherein the transmit segment includes
2 a single-ended filter wherein at receive band frequencies of the duplexer, an
3 open circuit is presented by the single-ended filter to the input/output line.

1 20. A duplexer as in claim 16 wherein the balun additionally
2 includes:
3 a first transmission line coupled between the input/output line and
4 the first output; and,
5 a second transmission line coupled between the input/output line and
6 the second output; and,

1 21. A duplexer as in claim 16 wherein the balun additionally
2 includes:

3 a first transmission line coupled between the input/output line and
4 the first output, a length of the first transmission line is chosen to cause a
5 phase delay of approximately one fourth wave length at receive band
6 frequencies of the duplexer; and,

7 a second transmission line coupled between the input/output line and
8 the second output, a length of the second transmission line is chosen to
9 cause a phase delay of approximately three fourths wave length at the
10 receive band frequencies of the duplexer.

1 22. A duplexer as in claim 16 wherein the differential filter includes
2 resonator elements connected so that at transmit band frequencies of the
3 duplexer, the first output and the second output are shorted.